HEKIMIAN LABORATORIES, INC.

12-5

OPERATING MANUAL
MODEL 4410A TRANSMISSION TEST SET

HEKIMIAN 4410/4410A

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PART NO. 4410A-M20
Issue 1, August 1985

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Manufactured by

HEKIMIAN LABORATORIES, INC.
9298 Gaither Road
Gaithersburg, Maryland 20877 USA

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1. GENERAL

1.01 This manual contains information necessary for installation and operation of the HLI Model 4410A Transmission Test Set. This section covers the functional description and specifications. Figure 1 shows the front and rear view of the Model 4410A.

DANGER: Hazardous voltages exist inside this instrument. There are no internal operator adjustments. Refer servicing to qualified personnel.

A. Functional Description

1.02 The Model 4410A is a compact, rack mounted instrument that measures level, noise, return loss and frequency. Combined with a multifunction signal generator and a flexible 2-Wire (2W)/4-Wire (4W) line interface configuration, it fulfills a variety of fixed plant testing requirements. The Model 4410A features microprocessor based circuitry for a high level of reliability, accuracy and operating convenience. Operating convenience is further enhanced by pushbutton controls arranged in functional groups.

1.03 Level measurements are made using an averaging type detector, while noise and return loss measurements are made using a quasi-RMS detector. The response range for level and frequency measurements extends from 40 Hz to 20 kHz with 1 Hz resolution. C-Message, 3 kHz Flat, and 15 kHz Flat weighting filters, together with a 1010 Hz Notch filter, are provided for message circuit noise and noise-to-ground measurements.

1.04 A switchable 60 Hz high-pass filter is provided to identify the effects of power line or other low frequency interference on measurements. The momentary action of the switch prevents inadvertent activation of this filter circuit when not desired.

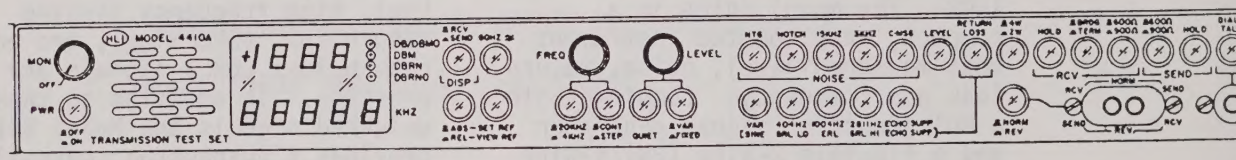
1.05 Return loss measurements can be made in 2W or 4W modes. To perform these measurements, sine wave, low frequency singing return loss (SRL Low), high frequency singing return loss (SRL High), and echo return loss (ERL) signals are provided. In addition to these weighted signals the Model 4410A provides a pushbutton controlled echo suppressor tone that can be transmitted as required.

1.06 The flexible signal generator features continuous or stepped frequency tuning. A low distortion, crystal controlled 1004 Hz noise measurement holding tone is provided. Two other crystal controlled frequencies, 404 Hz and 2811 Hz, are also provided for gain slope measurements. In addition to these fixed frequencies the Model 4410A provides a fixed level output of -16.0 dBm with a variable output, adjustable in 0.1 dB increments in a range between -50.0 dBm and +10.0 dBm.

1.07 The line interface can be established from front panel jacks or the rear panel barrier strip. The line interface allows send/receive circuit reversal, independent selection of a 600Ω or 900Ω termination impedance, independent send/receive hold circuits and a full 2W/4W dial/talk capability. The interface also allows for either bridged or terminated measurements.

B. Specifications

1.08 Specifications for the Model 4410A are contained in Table A.



Front View

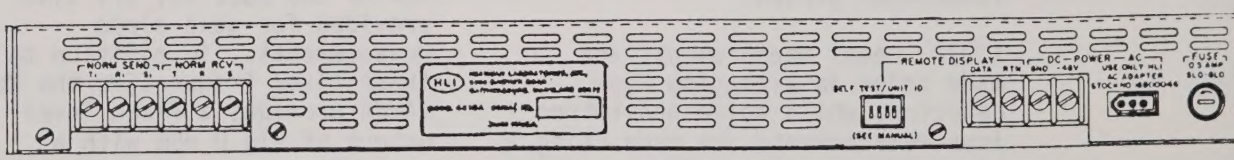


Figure 1. Model 4410A Transmission Test Set Front/Rear Views

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TABLE A. SPECIFICATIONS

GENERAL		
	Measurements	Level (dBm)
		Noise (dBrn)
		Return Loss (dB)
		Frequency (kHz)
	Modes	
	Absolute	Unit displays absolute measurements in dBm
	Relative	Unit displays relative measurements in dB, dBm0 or dBrn0 (Push-button SET REF control)
	Displays	Dual display: level, noise, or return loss and frequency
	Generator	Sine wave, fixed and variable frequency. Noise weighted for return loss
	Out-of-Range Indication	When input level or frequency is out-of-range, the display will indicate Hi or Lo
	Audio Monitor	Front panel speaker, volume control with ON/OFF switch
SEND/RECEIVE INTERFACE		
	Impedance	600Ω, 900Ω, or bridged (receive only)
	DC Blocking	150 V
	Return Loss	>30 dB, 200 Hz to 4 kHz
	Balance	>60 dB, up to 4 kHz
	Dial/Talk	Full 2W/4W capability with dual electronic hold circuits

TABLE A. SPECIFICATIONS (Cont.)

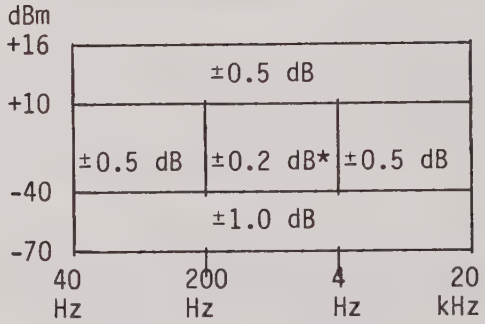
LEVEL MEASUREMENT	
Frequency Range	40 Hz to 20 kHz
Level Range	-80.0 dBm to + 16.0 dBm, full auto-ranging
Resolution	0.1 dB
Accuracy	 * ±0.1 dB at 1 kHz for levels between 0.0 dBm and -19.0 dBm
Detector Type	Average Responding
NOISE MEASUREMENT	
Modes	Noise (message circuit) Noise-to-ground
Weighting Filters	C-Message 3 kHz Flat 15 kHz Flat 1010 Hz Notch
Measurement Range	+10 dBrn to +100 dBrn (noise) +40 dBrn to +130 dBrn (noise-to-ground)
Resolution	1 dB
Accuracy	±1 dB (noise), +20 dBrn to +100 dBrn ±1.5 dB (noise-to-ground), +50 dBrn to +130 dBrn
Detector Type	Quasi-RMS

TABLE A. SPECIFICATIONS (Cont.)

RETURN LOSS MEASUREMENT	
4-Wire	
Measurement Range	-9.9 dB to +50.0 dB
Accuracy	±0.5 dB
2-Wire	
Measurement Range	0.0 dB to +50.0 dB
Standard Impedance	600Ω or 900Ω ± 1% in series with 2.16 µF ±1%, or external standard
Measurement Modes	SRL High SRL Low ERL Sine wave return loss
Resolution	0.1 dB
Detector Type	Quasi-RMS
FREQUENCY MEASUREMENT	
Frequency Range	40 Hz to 20 kHz (5 digits)
Level Range	-40.0 dBm to +10.0 dBm
Resolution	1 Hz
Update	2 times per second for receive 8 times per second for send
Accuracy	±0.005% of reading ±1 digit

TABLE A. SPECIFICATIONS (Cont.)

GENERATOR

Sine Wave

Frequency Ranges	100 Hz to 4 kHz 500 Hz to 20 kHz
Frequency Modes	Continuous 100.4 Hz step in 4 kHz Range 502 Hz step in 20 kHz Range 404 Hz, fixed 1004 Hz, fixed 2811 Hz, fixed
Distortion	>60 dB below signal, 1004 Hz fixed >50 dB below signal, 200 Hz to 4 kHz >40 dB below signal, 100 Hz to 20 kHz
Level Modes	-50.0 dBm to +10.0 dBm adjustable in 0.1 dB increments -16.0 dBm fixed Quiet termination
Return Loss	
Weighting	SRL High SRL Low ERL
Distortion	>30 dB below signal
Level Modes	-50.0 dBm to 0.0 dBm adjustable in 0.1 dB increments. -16.0 dBm fixed Quiet termination

TABLE A. SPECIFICATIONS (Cont.)

Echo Disable	Provides nominal 1-second burst of 2163 Hz to disable echo suppressor in test path
CONNECTORS	
Receive/Send	Front panel bantam jack Rear panel barrier strip
Dial/Talk	Front panel bantam jack
Power	
DC	-48V dc office battery, 20 watts
AC	115V ac with ac adapter, HLI stock number 16B00046*
MOUNTING	19 in (48.3 cm) or 23 (58.4 cm) rack mount
SIZE	17 in (43.2 cm)W x 1.75 in (4.5 cm) H x 9.4 in (23.9 cm)D
WEIGHT	6 lbs 4 oz (2.9 kg)
OPTIONS	.01-310 type jacks in place of bantam jacks .02-310 type jacks .03-Fixed output level other than -16 dBm (Consult Factory)

*The ac adapter HLI stock number 16B00046 must be ordered as a separate item.

All stated and unstated specifications are intended to comply with Bell System standards as contained in Bell System Technical Reference PUB 41009 dated May 1975.

HLI reserves the right to make changes in specifications at any time without notice.

2. CONTROLS, INDICATORS AND JACKS

2.01 This section contains the description of all controls, indicators and jacks on the Model 4410A Transmission Test Set. Refer to Figure 2 for the front panel controls, indicators and jacks, and Figure 3 for the rear panel.

A. Front Panel

1 PWR Switch: Turns the Model 4410A on and off.

2 MON Control: Turns off or adjusts the volume of the audio monitor.

3 LED Displays: Provide simultaneous information for level and frequency. Overrange conditions are indicated by "Hi" and underrange by "Lo". The frequency display is blank during all noise and return loss measurements with the exception of sine wave return loss. Appropriate units of measurement are given by LED indicators.

5 60 HZ Switch: Reduces the effect of power line interference on the measurements.

6 FREQ Control: Manual frequency adjustment for variable send frequency.

7 LEVEL Control: Manual adjustment for variable send level.

8 NTG Switch: Selects noise-to-ground measurement mode when used with any of the noise weighting filters.

9 NOISE Controls:

NOTCH - Inserts the 1010 Hz Notch filter to notch out the holding tone for noise-with-tone measurements.

15 KHZ/C-MSG - Sets the noise measurement modes with the selected weighting filter.

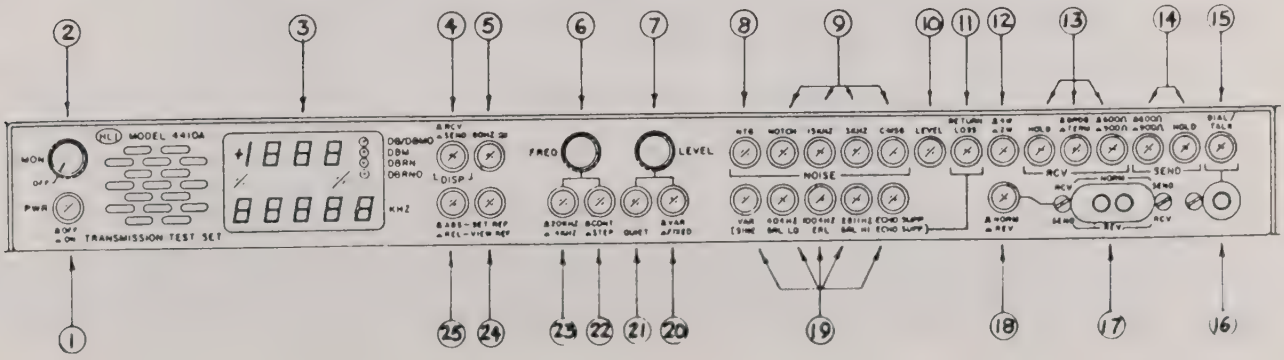


Figure 2. Front Panel Controls, Indicators and Jacks

10 LEVEL Switch: Sets the level measurement operational mode.

11 RETURN LOSS Switch: Sets the return loss measurement operational mode.

12 4W/2W Switch: Sets up the dial/talk and return loss circuitry for 4W or 2W operation.

13 RCV Line Interface Controls:

HOLD - Sets the hold circuit on the receive lines.

BRDG/TERM - Allows for either a high impedance bridged or terminated measurement on the receive lines.

600Ω/900Ω - Sets the receive termination impedance.

14 SEND Line Interface Controls:

600Ω/900Ω - Sets the send termination impedance.

HOLD - Sets the hold circuit on the send lines.

15 DIAL/TALK Switch: Sets the dial/talk mode and disables the normal send function.

16 DIAL/TALK Jack: Bantam type jack that provides an interface for either a handset or headset.

17 SEND/RCV Jacks: Bantam jacks that provide the interface between the test set and the circuit under test.

18 NORM/REV Switch: Determines which jack is connected to the send and receive circuitry. When set to NORM, the jack on the right is the send jack and the jack on the left is the receive jack. When set to REV, the jack functions are reversed.

19 Generator Frequency Controls: Dual-function switches which set the generator send frequency based on the measurement mode.

VAR/[SINE] - Allows a variable send frequency in the level/noise modes and sets a sine wave output in the return loss mode.

404HZ/[SRL LO] - Sets a 404 Hz test tone in the level mode, and sets a wideband noise output weighted for an SRL Low measurement in the return loss mode.

1004HZ/[ERL] - Sets a 1004 Hz test tone with better than 60 dB purity in the level/noise modes, and sets a wideband noise output weighted for an ERL measurement in the return loss mode.

2811HZ/[SRL HI] - Sets a 2811 Hz test tone in the level mode, and sets a wideband noise output weighted for an SRL High measurement in the return loss mode.

ECHO SUPP - Sends a nominal 1-second burst of a 2163 Hz echo suppressor disable tone.

20 VAR/FIXED Switch: Sets either a variable or a fixed -16.0 dBm send level.

21 QUIET Switch: Sets a quiet termination on the send circuit.

22 CONT/STEP Switch: Selects either continuous send frequency adjustments or discrete stepped adjustments. In the 4 kHz range the increments are 100.4 Hz steps, and in 20 kHz range the increments are 502 Hz steps.

23 20KHZ/4KHZ Switch: Sets either the 500 Hz to 20 kHz or 100 Hz to 4 kHz variable send frequency ranges for the generator.

24 SET REF/VIEW REF Switch: Sets the value displayed as the reference for the relative mode when the ABS/REL switch is in ABS. With the ABS/REL switch in REL, it allows the user to view the reference level in use.

25 ABS/REL Switch: Allows level readout to be either absolute or relative to the preset reference level.

B. Rear Panel

1 FUSE Holder: Contains ac power line safety fuse. The fuse is a MDL-1/2 type fuse rated at 0.5 amp (3AG Slo-blo).

2 AC ADAPTER Receptacle: Used with the HLI Stock No. 16B00046 wall-mounted AC Adapter when the Model 4410A is powered by ac power.

3 GND/-48V Connections: Provide the power input when the Model 4410A is powered by office battery. The GND terminal also provides chassis ground.

4 DATA/RTN Connections: Provide the interface to a remote display.

5 SELF TEST/UNIT ID Switch: Programs the unit address. It is a four-segment DIP switch which is also used to set up test conditions in the self-test mode.

6 NORM SEND/NORM RCV Connections: Provide a parallel connection to the associated line interface jack on the front panel. These connections are broken when a plug is inserted into the associated front panel jack.

Figure 3. Rear Panel Connections and Controls

3. POWER CONSIDERATIONS

3.01 This section contains information concerning the power requirements and the power connections available on the Model 4410A.

3.02 The Model 4410A can be operated from -48V dc office battery or from a 115V ac source. The office battery power leads can be connected directly to the Model 4410A. However, when an ac power source is used, the Model 4410A is connected to the ac source via a wall mounted ac adapter, HLI Stock No. 16B00046. Operating current demand is 0.5 amps or less and the unit is fused with a 0.5 amp, MDL-1/2 type (3AG Slo-blo) fuse. The fuse is accessible from the rear panel. Refer to Figure 3 for the fuse location.

WARNING: For continued protection against fire or equipment damage, only replace with a fuse of the specified type and rating.

A. DC Power

3.03 Connections to the office battery power leads are made via a barrier strip mounted on the rear panel of the Model 4410A. The office ground, or positive lead, connects to the Model 4410A ground terminal labeled GND. This terminal also provides chassis ground for the Model 4410A. The -48V, or negative office power lead, is connected to the terminal labeled -48V on the Model 4410A. Refer to Figure 3 for the location of these connections. The Model 4410A will operate with voltages that fluctuate from -42V dc to -56V dc.

3.04 Since the Model 4410A derives its chassis ground via the GND terminal, when powered by office battery , a positive ground or earth ground source must always be connected to this terminal. If a battery power source that does not have positive grounding is used, it is recommended that the power source be isolated and the positive terminal of the source be connected to the GND terminal on the Model 4410A, along with an independent earth ground.

B. AC Power

3.05 The Model 4410A can be powered from a 115V ac, 60 Hz source, when connected to a wall-mounted ac adapter, HLI Stock No. 16B00046. The ac adapter is supplied as a separate assembly, and is connected to the Model 4410 via a receptacle found on the rear panel. Refer to Figure 3 for the location of this receptacle. The ac adapter is designed to be mated with a three-prong, NEMA 5-15R type ac power receptacle. The Model 4410A must be mounted within 6 feet of the receptacle.

3.06 Chassis ground is provided via the third conductor in the ac adapter cord, when the Model 4410A is powered by an ac power source. If the NEMA 5-15R type receptacle is used, this conductor is connected to the power line ground.

To retain this protective feature when the ac adapter must be plugged into a 2-wire outlet, use a 3-conductor to 2-conductor adapter and connect the adapter wire to an appropriate ground.

3.07 If for any reason the chassis cannot be grounded through the power cord, the chassis must be connected to an earth ground via the GND terminal on the rear panel of the Model 4410A.

4. INSTALLATION

4.01 This section contains information necessary to properly set up and install the Model 4410A Transmission Test Set.

4.02 The Model 4410A is designed for rack mounting within equipment bays. See Figures 4 and 5. Detachable mounting ears and flexible ear mounting configurations accommodate several rack mounting requirements. The "L" shaped mounting ears can be attached to mount the unit in 19" or 23" racks so that the front of the Model 4410A is in either a flush mount or 5" forward projection mounting configuration relative to the equipment rack. The units are shipped from the factory configured for flush mounting in a 19" wide rack. Changing to another mounting configuration can be accomplished with a 3/16" flat blade screwdriver.

4.03 The Model 4410A should not be mounted where the air flow through the chassis vents will be impeded. Restricting the air flow may lead to overheating the unit and possible damage. With proper ventilation, the Model 4410A will operate at ambient temperatures as high as 50° C. The unit should not be exposed to excessive humidity or moisture which may condense on, or in the unit. Moisture from condensation may cause unit failure.

A. Tools Required

4.04 The tools required to mount the Model 4410A to the rack will be determined by the type of mounting hardware used. No rack mounting hardware is supplied with this unit. A 3/16" flat blade screwdriver is the only tool necessary to set up the Model 4410 itself.

B. Preparation for Mounting

4.05 Remove the Model 4410A from its shipping container, and perform a complete visual inspection for possible damage. If damage is found, notify the carrier immediately; do not destroy any packing material until an agent of the carrier has examined it. Under U. S. shipping regulations, damage claims must be submitted by the consignee; do not return the instrument to Hekimian Laboratories, Inc., until a claim for damage has been established.

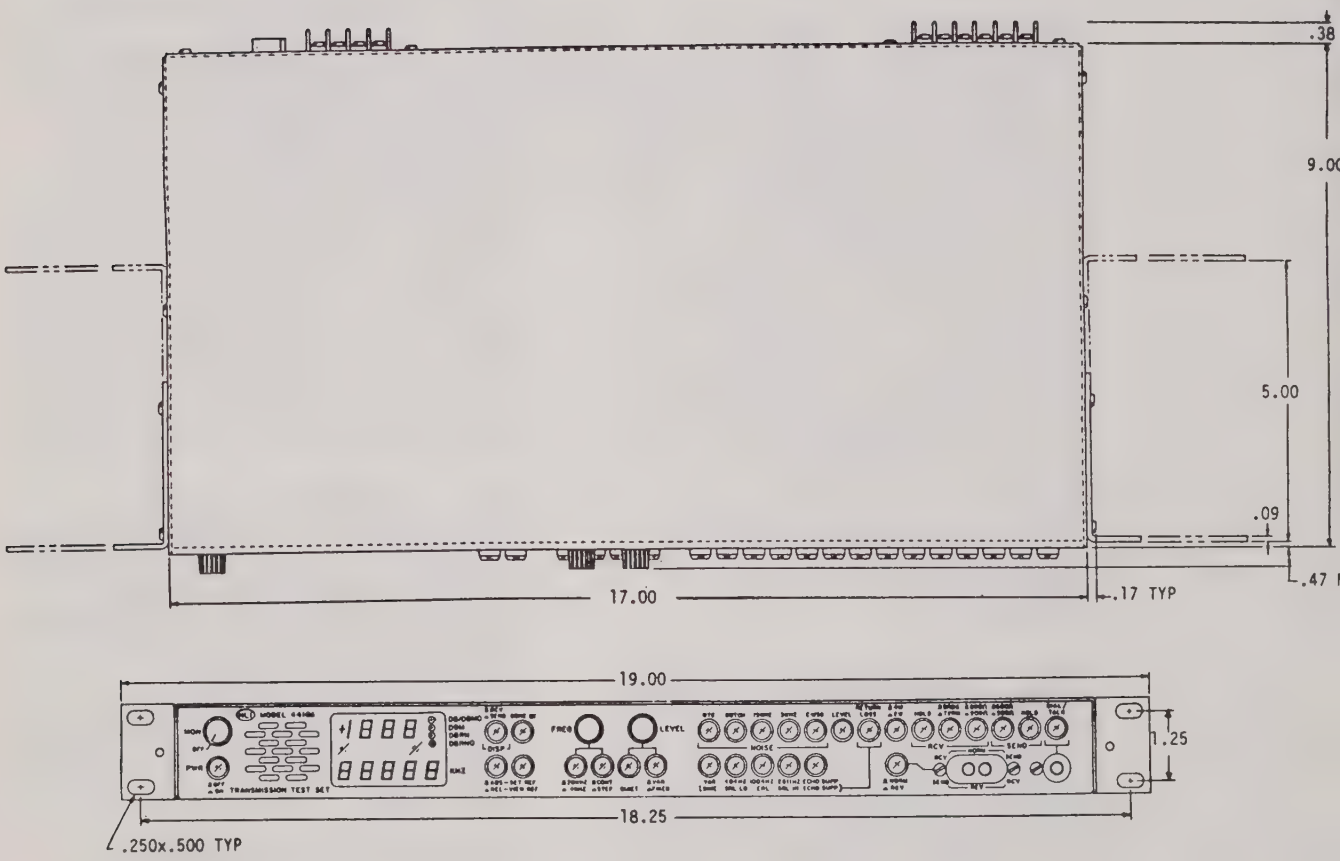
4.06 Preparation of the Model 4410A for mounting involves configuring the mounting ears for the rack mounting arrangement desired. Preparation requirements for each of the four possible mounting arrangements are identified in the following procedures. To prepare the Model 4410A for installation perform the following:

Flush Mounting in 19" Rack

The Model 4410A is shipped from the factory configured for flush mounting in a 19" rack. No further preparation is required.

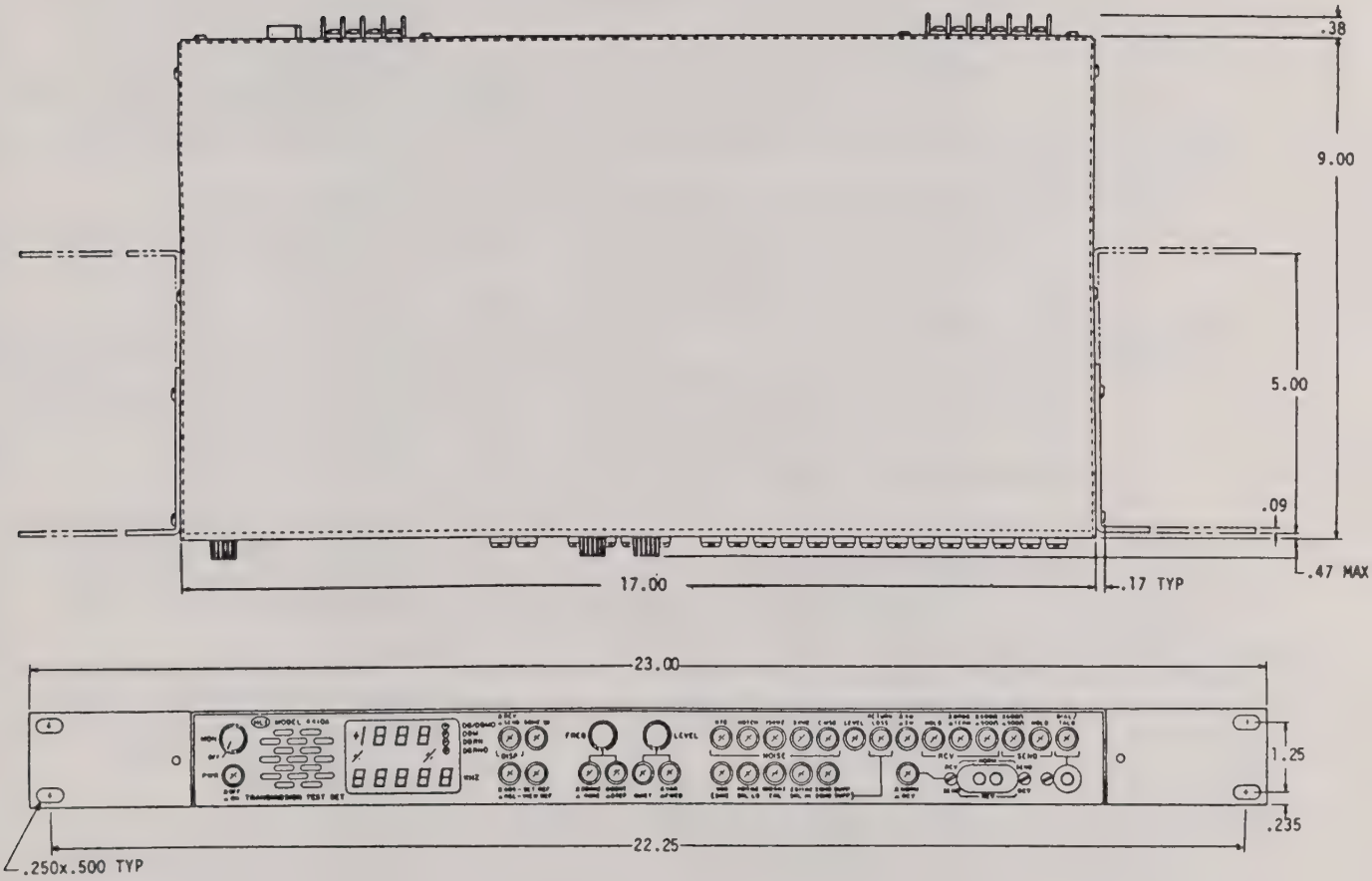
Flush Mounting 23" Rack

STEP	ACTION
1	Remove the 3 screws holding the "L" shaped mounting ear to the Model 4410A chassis.



Note: All measurements in inches.

Figure 4. 19" Wide Rack Mounting Diagram



Note: All measurements in inches.

Figure 5. 23" Wide Rack Mounting Diagram

STEP	ACTION
	NOTE: Take care not to lose the washers attached to the 2 screws removed from the countersunk, slotted holes. These washers are necessary to properly secure the mounting ears.
2	Locate the three mounting holes that form a triangular pattern on the side of the unit chassis towards the front panel.
3	Center the three mounting holes on the short leg of the "L" shaped mounting ear over the three chassis mounting holes located in Step 2.
	NOTE: The long leg of the mounting ear should align with the front panel.
4	Install the 3 mounting screws.
	NOTE: Ensure that the screws with the washers are installed in the countersunk, slotted holes.
5	Repeat Steps 1 through 4 to install the other mounting ear.

5 Inch Forward Projection Mounting 19" Rack

STEP	ACTION
1	Remove the 3 screws holding the "L" shaped mounting ear to the Model 4410A chassis.
	NOTE: Take care not to lose the washers attached to the 2 screws removed from the countersunk, slotted holes. These washers are necessary to properly secure the mounting ears.
2	Remove the chassis assembly screw located in the lower center of the unit side.
3	Install the assembly screw removed in Step 2 in the hole located on the unit side lower corner towards the front panel.
4	Locate the single mounting hole positioned between the vent slots in the center of the unit side.
5	Reposition the long leg of the "L" shaped ear over the three mounting holes in the center of the chassis side.
	NOTE: The long leg of the ear is against the chassis, and points toward the front panel with the round mounting hole centered over the hole located in Step 4.
6	Install the 3 mounting screws.
	NOTE: Ensure that the screws with the washers are installed in the countersunk, slotted holes.

STEP	ACTION
7	Repeat Steps 1 through 6 to install the other mounting ear.

5 Inch Forward Projection Mounting in 23" Rack

1	Remove the 3 screws holding the "L" shaped mounting ear to the Model 4410A chassis. **NOTE:** Take care not to lose the washers attached to the 2 screws removed from the countersunk, slotted holes. These washers are necessary to properly secure the mounting ears.
2	Remove the chassis assembly screw located in the lower center of the unit side.
3	Install the assembly screw removed in Step 2 in the hole located on the unit side lower corner towards the front panel.
4	Locate the single mounting hole positioned between the vent slots in the center of the unit side.
5	Reposition the short leg of the "L" shaped ear over the three mounting holes in the center of the chassis side. **NOTE:** The short leg of the ear is against the chassis, and points toward the front panel with the round mounting hole centered over the hole located in Step 4.
6	Install the 3 mounting screws. **NOTE:** Ensure that the screws with the washers are installed in the countersunk, slotted holes.
7	Repeat Steps 1 through 6 to install the other mounting ear.

C. Unit Mounting

4.07 There are no unique requirements for mounting the Model 4410A in the equipment rack. The mounting ears are designed with slotted mounting holes spaced on standard 1.25" vertical hole centers for ease of alignment. No mounting hardware is supplied with the unit, so no specific mounting instructions are provided. No specific rack installation profile is identified or required. However, the following points must be considered when installing the Model 4410A:

- Do not mount the unit where the chassis air vents will be blocked.
- Do not mount the unit where it will be exposed to excessive humidity or moisture.

- If the unit is powered from an ac source, it must be mounted within 6 feet of a three-prong, NEMA 5-15R type power receptacle.

D. Power Hook-Up

4.08 The Model 4410A operates on either 115V ac power or -48V dc office battery. When an ac source is used, simply insert the special purpose plug on the ac adapter assembly, HLI Stock No. 16800046, into the receptacle located on the rear panel of the Model 4410A. When -48V dc office battery is used, perform the following:

STEP	ACTION
	WARNING: When powered by -48V office battery, the Model 4410A terminal labeled GND must be connected to a positive or earth ground for proper chassis grounding. Refer to paragraph 3.04 for details.
1	Connect the office ground or positive lead to the terminal labeled GND on the rear panel of the Model 4410A.
2	Connect the -48V lead from the office battery to the terminal labeled -48V on the rear panel of the Model 4410A.

E. Remote Display Hook-Up

4.09 The Model 4410A is designed to operate with remote aisle displays and remote scanner (or switching) units, should these units become available. When in this configuration, the test information displayed on the Model 4410A is transmitted to a remote display unit. To connect the Model 4410A with the remote display or scanner is easy, but will depend on the configuration of the equipment used. The Model 4410A can either be connected directly to a single remote display or a remote scanner unit. It is connected to a remote scanner when used in a facility where several Model 4410As must operate multiple remote displays. The Model 4410A must be coded with a unit ID number when used with the remote scanner. This allows connection of specific Model 4410As to remote displays as required. These unit ID's are set via a 4-segment DIP switch located on the rear panel of the Model 4410A. The actual switch settings for the various ID's are found in Table B.

4.10 To connect the Model 4410A to a remote display and/or scanner, proceed as follows:

STEP	ACTION
1	Connect the display scanner return or negative lead to the terminal labeled RTN on the rear panel of the Model 4410A.
2	Connect the display scanner data input lead to the terminal labeled DATA on the rear panel of the Model 4410A.

STEP	ACTION
3	Set the 4-segment DIP switch labeled SELF TEST/UNIT ID, located on the rear panel of the Model 4410A, to the desired unit ID shown in Table B. **NOTE:** Do not duplicate the unit ID for Model 4410A controlled via the same remote scanner unit.
4	The DIP switch must be set at "0" on all four segments when connections to remote scanner or displays are removed.

TABLE B. MODEL 4410A UNIT ID FOR REMOTE SCANNER OPERATION

SELF TEST/UNIT ID SWITCH				
UNIT ID	SEGMENTS			
	1	2	3	4
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

1 = On
0 = Off

NOTE: A unit ID of "0" should be encoded on any unit not connected to a remote scanner.

5. FUNCTIONAL TESTS

5.01 This section describes the lamp test and functional checks which can be performed on the Model 4410A.

5.02 There are certain functional checks that can be performed on the Model 4410A to confirm proper operation of the unit. These tests are only meant to verify proper operation of the unit and are not to be used for calibration purposes. The functional tests should be performed at the time of unit installation, and when unit malfunction is suspected.

NOTE: There is no user authorized repair or calibration for these units. If a possible malfunction is detected, contact the factory for advice and the necessary corrective action.

5.03 To conduct the functional tests of the Model 4410A, proceed as follows:

A. Lamp Test

STEP	ACTION	VERIFICATION
1	Set the SELF TEST/UNIT ID switch located on the rear panel of the Model 4410A to the Lamp Test code listed in Table C.	
2	Push in the PWR switch to turn the unit on.	The DB/DBMO/DBM/DBRN/ DBRNO display reads +188.8, with all three unit LEDs lit. The KHZ display reads 88.888.
3	Push in and release the PWR switch to turn the unit off.	
4	Reset the SELF TEST/UNIT ID Switch to a normal operating unit ID listed in Table B. **NOTE:** Set the unit ID to "0" when not used with a remote scanner.	

TABLE C. MODEL 4410A FUNCTIONAL CHECK CODES

SELF TEST/UNIT ID SWITCH				
TEST FUNCTION	SEGMENTS 1	2	3	4
Lamp Test	0	1	1	1
Factory Calibration Test	1	1	1	1
0.1 dB Noise Measurement Resolution (factory calibration)	1	0	1	1

1 = On
0 = Off

NOTE: The Lamp Test code is the only operator usable code. The other two codes listed are for factory calibration purposes and will not provide any meaningful information to an operator. The codes are provided because inadvertently setting the SELF TEST/UNIT ID Switch to any of these codes will give the impression the unit is not functioning properly.

B. Functional Checks

Unit Setup

NOTE: Improper setting of the SELF TEST/UNIT ID switch located on the rear panel of the Model 4410A may lead to failure of the functional checks. Verify that the SELF TEST/UNIT ID switch is set to one of the unit ID's listed in Table B prior to conducting the functional checks.

STEP	ACTION
1	Connect a bantam patch cord from the NORM RCV jack to the NORM SEND jack on the Model 4410A.
2	Set the DIAL/TALK switch out.
3	Set the SEND HOLD switch out.
4	Set the RCV HOLD switch out.
5	Set the SEND 600Ω/900Ω switch to 600Ω.
6	Set the RCV 600Ω/900Ω switch to 600Ω.
7	Set the RCV BRDG/TERM switch to TERM.
8	Set the 4W/2W switch to 4W.
9	Set the NOTCH switch out.
10	Set the NORM/REV switch to NORM.

Measurement Check

STEP	ACTION	VERIFICATION
1	Set the LEVEL switch in.	
2	Set the DSPL RCV/SEND switch to SEND.	
3	Set the 1004HZ/[ERL] switch in.	
4	Set the VAR/FIXED switch to FIXED.	
5	Set the QUIET switch in.	
6	Set the CONT/STEP switch to CONT.	
7	Set the 20KHZ/4KHZ switch to 4KHZ.	
8	Set the ABS/REL switch to ABS.	
9	Push in the PWR switch to turn unit on.	The display shows a level of -16.0 dBm ±0.2 dB and a frequency of 1.004 ±0.002 kHz.
10	Adjust the MON knob to a comfortable listening level.	An audio tone is present.
11	Set the DSPL RCV/SEND switch to RCV	The display gives a "Lo" indication and the audio tone is no longer present Only slight random noise may be heard.
12	Set the QUIET switch out.	The display shows a level of -16.0 dBm ±0.2 dB and a frequency of 1.004 ±0.002 kHz.
13	Set the VAR/FIXED switch to VAR.	

STEP	ACTION	VERIFICATION
14	Adjust the LEVEL knob to set a -10.0 dBm level.	The display shows a level of -10.0 dBm and a frequency of 1.004 ±0.002 kHz.
15	Momentarily depress the SET REF/ VIEW REF switch to set a -10.0 dBm reference level.	The display flashes.
16	Set the ABS/REL switch to REL.	The display shows a level of either (+) or (-) 0.0 dBm0.
17	Adjust the LEVEL knob to set a -10.1 dBm0 level	The display shows a level of -10.1 dBm0 and a frequency of 1.004 kHz.
18	Set the C-MSG switch in.	The display shows a level of +80.0dBrn ±0.1dB and no frequency.
19	Push in and hold the SET REF/VIEW REF switch.	The display shows a level of -10 dB and a frequency of 1.004 ±0.002 kHz.
20	Set the RETURN LOSS switch in.	The display shows a level of +10.0 ±1.0 dB and no frequency.
21	Set the DSPL RCV/SEND switch to SEND.	
22	Set the ABS/REL switch to ABS.	
23	Set the LEVEL switch in.	The display shows a level of -20.1 dBm ±0.1 dB and a frequency of 1.004 ±0.002 kHz.

Generator Check

STEP	ACTION	VERIFICATION
1	Set the 2811HZ/[SRL HI] switch in.	The display shows a frequency of 2.811 ±0.002 kHz.
2	Set the 404HZ/[SRL LO] switch in.	The display shows a frequency of 0.404 ±0.002 kHz.
3	Set the VAR/[SINE] switch in.	
4	Turn the FREQ knob counter-clockwise until it stops turning.	The display shows a frequency of <0.100 kHz or it may even give a "Lo" indication.
5	Turn the FREQ knob clockwise.	The frequency display changes continuously.
6	Set the CONT/STEP switch to STEP.	
7	Continue to turn the FREQ knob clockwise.	The frequency display changes in steps.
8	Turn the FREQ knob clockwise until it stops.	The display shows a frequency of >4.000 kHz.
9	Set the 20KHZ/4KHZ switch to 20KHZ.	The display shows a frequency of >20.000 kHz or it may even give a "Hi" indication.
10	Set the RETURN LOSS switch in.	The frequency display is unchanged from Step 9.
11	Set the 404HZ/[SRL LO] switch in.	The frequency display is blank and a low frequency audio noise signal is heard via the monitor.
12	Set the 2811HZ/[SRL HI] switch in.	The frequency display is blank and a high frequency audio noise signal is heard via the monitor.

STEP	ACTION	VERIFICATION
13	Set the 1004HZ/[ERL] switch in.	The frequency display is blank and a mid-range audio noise signal is heard via the monitor.
14	Momentarily depress the ECHO SUPP switch.	The mid-range audio noise signal is interrupted by about 1 second of a single frequency tone at 2163 Hz.
15	Push in and release the PWR switch to turn the unit off. **NOTE:** Turning the unit off will clear the relative reference setting used during the functional tests. Failure to reset the reference setting may lead to erroneous test results.	
16	Remove the patch cord connected in Step 1 of the unit set up.	

6. OPERATION

6.01 This section describes the Model 4410A features, line interface, dial/talk mode, transmitter set up, relative measurement set up and the measurement procedures.

A. Features

6.02 Independent receive and send circuits provide very flexible line interface capabilities. Each circuit has independently switch-settable holding circuits and balanced impedances of 600Ω and 900Ω. This allows the Model 4410A to simultaneously send and receive when testing 4-wire circuits, and greatly eases the operation when testing 2-wire circuits. By using the NORM/REV switch, the send and receive circuits can be alternately inserted on the same 2-wire access.

6.03 A 4-wire interface is provided via front panel mounted bantam jacks. One jack handles the send pair in the 4-wire circuit and the other the receive pair. A 2-wire access is possible through either bantam jack. These jacks are also connected in parallel to a rear panel mounted barrier strip. This allows for hard wiring the desired interface with no loss in the functions available from the front panel. Connecting a plug to the front panel jack will disconnect the associated circuit to the rear panel terminals.

6.04 Versatile dial/talk circuitry allows access to the circuit under test via a lineman's handset. Access to the Model 4410A is made via a front panel mounted bantam jack. The Model 4410A operates in the dial/talk mode on both 2-wire and 4-wire circuits. In addition, the Model 4410A will automatically provide talk battery when operating in the 4-wire dial/talk mode.

6.05 A preset echo suppressor disable tone is available. A front panel mounted momentary switch transmits a nominal 1 second burst of a 2163 Hz disable tone whenever depressed. When the Model 4410A is in the transmit mode, this tone will disable any echo cancellor or suppressor on the circuit under test. This greatly facilitates the performance of return loss measurements on echo cancelled or suppressed circuits.

6.06 A filter that provides a minimum of 20 dB of attenuation at 60 Hz is available. The filter is activated via a front panel mounted momentary switch. This filter provides the ability to determine the effects of low frequency or power line interference on the level and frequency test results. Pushing in and holding the switch will allow the operator to observe the effects of this interference on the displayed measurement. The switch is a momentary action switch to prevent inadvertent insertion of the filter when not needed.

6.07 The ability to set a relative reference level is available. The Model 4410A can be set up to provide a measurement relative to a 0 transmission level point (TLP), when the measurement is made at some TLP other than a 0 point.

Depressing the front panel mounted momentary switch labeled SET REF/VIEW REF will set whatever level is shown on the display as the reference level for that TLP. Once set, the Model 4410A will automatically adjust the level/frequency measurement values relative to measurements made at a 0 TLP.

6.08 Display indicators are provided to show when the measurement conditions exceed the measurement capability of the Model 4410A. If the upper limit of a particular measurement range is exceeded, a "Hi" is displayed; for measurements that exceed the lower limit, a "Lo" is displayed.

6.09 A front panel mounted speaker provides an audio monitor for whatever signal is being measured and displayed. The audio monitor signal is obtained from the autoranging amplifier output, thus making low level signals audible. This feature permits audio detection of low level interference. The audio output can be adjusted to any desired listening level, or completely turned off via the front panel mounted knob labeled MON.

6.10 The ability to perform a noise-to-ground measurement is available via a front panel mounted momentary switch labeled NTG. When this switch is activated in conjunction with the appropriate message circuit noise weighting filter, the noise-to-ground reading referenced to a 600Ω impedance is displayed. The momentary action of the switch prevents inadvertent activation of the noise-to-ground measurement circuitry during normal message circuit noise measurements.

B. Line Interface

6.11 The line interface is provided via two front panel mounted bantam jacks, or a rear panel mounted barrier strip. The front panel mounted jack labeled NORM SEND is connected in parallel with the barrier strip terminals labeled NORM SEND, and similarily the NORM RCV jack to the NORM RCV terminals. An interface can be established using either access, but whenever a connection is made via the front panel jack, the associated rear panel terminals are automatically disconnected. The receive and send circuitry is controlled independently of the lin interface jacks, allowing the NORM/REV switch to change the jack functions. The independent send and receive circuitry also accommodates the flexible line interface, because of the capability to send and receive simultaneously.

6.12 To set up the line interface with the Model 4410A, proceed as follows:

STEP	ACTION
1	Connect a bantam patch cord from the test circuit to the jack labeled NORM SEND.

NOTE: In the NORM jack configuration this connects the Model 4410A transmitter output to the test circuit. On a 4-wire circuit this connects to the receive pair of the circuit under test. On a 2-wire circuit this jack is used if there is a requirement to transmit a test tone in support of far-end testing or to perform return loss measurements.

STEP	ACTION
2	Connect a bantam patch cord from the test circuit to the jack labeled NORM RCV. **NOTE:** In the NORM jack configuration this connects the Model 4410A receive circuitry to the test circuit. On a 4-wire circuit this connects to the transmit pair of the circuit under test. On 2-wire circuits this jack is used if performing far-to-near level/frequency and noise measurements.
3	Set the SEND 600Ω/900Ω switch to the impedance which matches the test circuit line impedance.
4	Set the RCV 600Ω/900Ω switch to the impedance which matches the test circuit line impedance. **NOTE:** Improper setting of these switches will lead to an impedance mismatch resulting in incorrect measurement results.
5	Set the NORM/REV switch to NORM. **NOTE:** This switch provides the means to change the Model 4410A circuitry connected to the jack. The jack which provides the transmitter output in the NORM position of the switch will be connected to the receive circuitry in the REV position; and at the same time, the receive jack becomes the transmitter output. This is especially helpful in two-way testing of 2-wire circuits where the transmit and receive functions of the Model 4410A are used alternately via the same jack interface.
6	Set the 4W/2W switch for the type of test circuit accessed.

C. Dial Talk Mode

6.13 The dial/talk circuitry enables a lineman's handset to be used to dial-up, answer-on, and talk over a 2-wire circuit to be tested, and listen and talk on a 4-wire circuit. In the 2-wire mode the operator will talk and listen via the handset, whereas in the 4-wire mode the operator talks with the handset and listens via the audio monitor on the Model 4410A. The Model 4410A provides talk battery when operating in the 4-wire mode. Setting the front panel mounted switch labeled 4W/2W establishes the appropriate dial/talk mode of operation when in the dial/talk mode.

6.14 To operate the Model 4410A in the dial/talk mode, proceed as follows:

STEP	ACTION
1	Set the line interface using the procedures outlined in paragraph 6.12.
2	Set the RCV HOLD switch out.
3	Set the RCV BRDG/TERM switch to BRDG.

STEP	ACTION
4	Set the SEND HOLD switch out.
5	Set the DSPL RCV/SEND switch to RCV. **NOTE:** This sets the audio monitor to listen in the 4-wire dial/talk mode. Insure the audio monitor is on and set to comfortable listening level.
6	Connect a lineman's handset to the DIAL/TALK jack. **NOTE:** The handset may remain connected to the DIAL/TALK jack during measurements without affecting the test results.
7	Set the DIAL/TALK switch in.
8	Complete the circuit, performing signaling with the handset. **NOTE:** The lineman's handset holds the circuit in the dial/talk mode. To avoid inadvertent loss of the circuit when changing from the dial/talk mode to the measurement mode, set the RCV HOLD and SEND HOLD switches "in" prior to releasing the dial/talk switch. This turns on the electronic holding circuits in the Model 4410A.
9	Set the DIAL/TALK switch out to perform test measurements. **NOTE:** Failure to set this switch out, releasing the Model 4410A from the dial/talk mode, will result in erroneous test measurements.

D. Transmitter Set Up

6.15 The Model 4410A has the capability to transmit signals over a wide range of frequencies and levels. As an aid to operation, the Model 4410A provides three preset switch-selectable frequencies and one preset level setting. Preset frequencies of 404 Hz, 1004 Hz, and 2811 Hz are provided to simplify the performance of gain slope, level/frequency, and noise-with-tone measurements. A preset level of -16.0 dBm is provided as the standard fixed level but can be ordered at some other level on an optional basis. In addition to the fixed values, both level and frequency can be adjusted via front panel mounted potentiometers. The level is adjustable in a range from -50.0 dBm to +10.0 dBm in .1 dB increments, and the frequency from 100 Hz to 20 kHz. The frequency is adjustable in two different bandwidths, 100 Hz to 4 kHz for voice grade circuits and 500 Hz to 20 kHz for wideband circuits. The frequency can also be adjusted in either a continuous mode of 1 Hz increments or a stepped mode. In the 4 kHz range the steps are equal to 100.4 Hz, and in the 20 kHz range they are equal to 502 Hz.

6.16 The Model 4410A is capable of transmitting properly weighted wideband noise signals in support of return loss measurements. Weighted signals for SRL Low, ERL, and SRL High measurements are preset and switch-selectable from the front panel. In addition to these signals, the Model 4410A will support single frequency return loss measurements in the variable frequency mode of operation. In all cases, the transmit level is adjustable from -50.0 dBm to 0.0 dBm in .1 dB increments.

6.17 To set up the transmitter, proceed as follows:

STEP	ACTION
1	Set the QUIET switch in.
	NOTE: This prevents inadvertent transmission of the signal.
2	Determine the type of test measurement to be performed.
3	Set either the LEVEL or RETURN LOSS switch in, depending on the operational mode determined in Step 2.
	NOTE: Setting the LEVEL switch "in" sets the transmitter operational mode for level/frequency and noise-with-tone measurements. Setting the RETURN LOSS switch "in" sets the transmitter return loss operational mode.
4	Set the DSPL RCV/SEND switch to SEND.
	NOTE: The transmitter level and frequency will be displayed for level/frequency, noise, and single frequency return loss outputs. Only the level is displayed for SRL Low, ERL, and SRL High output signals.
5	Set the 20KHZ/4KHZ switch to the type of circuit to be tested.
	NOTE: The 4KHZ setting is used for voiceband circuits and the 20KHZ setting for wideband circuits.
6	Set the VAR/FIXED switch to the desired level adjustment mode.
7	Adjust the knob labeled LEVEL if the variable adjustment mode was chosen in Step 6.
	NOTE: Turning the knob clockwise increases the level in increments of .1 dB and turning counter-clockwise decreases the level in similar increments. Adjusting the level outside the range of the transmitter causes either a "Hi" or "Lo" to be displayed depending on the limit exceeded.
8	Select the signal output to be transmitted.

STEP	ACTION
	NOTE: The transmitter output signal is chosen from the dual function switches labeled: VAR/[SINE], 404HZ/[SRL LO], 1004HZ/[ERL], and 2811HZ/[SRL HI]. The transmitter functions labeled in black are used for level/frequency and noise-with-tone measurements; the functions labeled in red are used for the return loss measurements.
9	Set the switch in for the desired transmitter output function.
10	Set the CONT/STEP switch to the desired frequency adjustment mode if the VAR/[SINE] switch was selected in Step 9.
	NOTE: Setting the switch to CONT allows adjustments in 1 Hz increments, and setting to STEP allows steps of 100.4 Hz in the 4 kHz range and 502 Hz in the 20 kHz range.
11	Adjust the knob labeled FREQ if the variable adjustment mode was selected in Step 9.
	NOTE: Turning the knob clockwise increases the frequency, and a counter-clockwise adjustment decreases the frequency.
12	Set the line interface using the procedures outlined in paragraph 6.12.
	NOTE: It may be necessary to hold up certain supervisor relays in the telephone offic with a dc hold current in order to maintain transmissio over the facility. Set the SEND HOLD switch in on a 2-wire circuit, or RCV HOLD in on 4-wire circuit, to provide this holding current, if required.
13	Set the QUIET switch out to permit transmission of the signal.

E. Relative Level Measurement

6.18 The Model 4410A has the capability to automatically correct measurements made at some point other than a 0 TLP to a measurement value relative to the 0 TLP. Typically in test sets that do not contain this feature, the operator must calculate the difference between the absolute measurement made at the point of test and the 0 TLP. However, once set up for a "relative measurement," the Model 4410A provides the adjusted level measurement directly on the display. The following example describes the principal of a relative measurement.

Example:

Level/frequency circuit limits are expressed in reference to 0 TLP.

A level measurement corrected to a 0 TLP is expressed as dBm0.

Level					
+7 TLP	Absolute Measurement→	-6.0 dBm	-16 TLP	Absolute Measurement→	-29.0 dBm
-7	←Correction Factor→	-7	+16	←Correction Factor→	+16
0 TLP	Measurement Corrected to 0 TLP→	-13.0 dBm0	0 TLP	Measurement Corrected to 0 TLP→	-13.0 dBm0
Relative Measurement→ Model 4410A		-13.0 dBm0			-13.0 dBm0

Note: The DB/DBM0 units indicator LED lights on the Model 4410A during relative measurements to distinguish these measurements from absolute measurements. During absolute level/frequency measurements, the DBM unit indicator LED is on.

6.19 To set up the Model 4410A to perform a relative level/frequency measurement, proceed as follows:

STEP	ACTION	VERIFICATION
1	Set the QUIET switch in. **NOTE:** This prevents inadvertent transmission of the signal.	
2	Set the DSPL RCV/SEND switch to SEND.	
3	Set the ABS/REL switch to ABS.	
4	Set the LEVEL switch in.	level and frequency are displayed.
5	Set the 1004KHZ/[ERL] switch in.	1.004 kHZ is displayed.
6	Set the VAR/FIXED switch to VAR.	
7	Adjust the LEVEL knob.	The TLP is displayed as a level reading. As an example, if the TLP is -16.0, that is what should be displayed.
8	Push in and momentarily hold the SET REF/VIEW REF switch.	Flashing display indicates the TLP reference is set.
9	Set the ABS/REL switch to REL. **NOTE:** With the ABS/REL switch set to REL, whatever level is displayed is corrected to a dBm0 reading. This rule also applies when setting the output of the transmitter. The output can be read directly in dBm0, if the TLP adjustment has been made in accordance with steps 1 through 8 above, and the ABS/REL switch is set to REL.	A level of (+) or (-) 0.0 is displayed. The DB/DBM0 unit indicator LED is on.
10	Push in and hold the SET REF/VIEW REF switch.	The reference TLP set in Step 8 is displayed.

F. Absolute Level and Frequency Measurement

6.20 The Model 4410A LEVEL mode of operation allows measurement of 1000 Hz loss, gain slope and attenuation distortion, all of which define the amplitude versus frequency response of a voice circuit. Frequency shift, which is a comparison of a known transmitted frequency against a received frequency, is also measured in this mode. The frequency shift measurements check for any frequency translation problems caused by carrier facilities.

6.21 The 1000 Hz loss measurement determines the point-to-point loss or gain in a circuit by comparing a 1004 Hz signal transmitted at a known level against the received level. Subtracting the received level from the transmitted level provides the circuit loss or gain in dB. Although described as 1000 Hz loss, the transmitted frequency is actually 1004 Hz to prevent measurement errors caused by test frequencies, which are submultiples of the T-carrier sampling rate.

6.22 The gain slope measurement is also a circuit loss measurement but is measured against three reference frequencies. Gain slope determines the usable bandwidth of the circuit by comparing the differential loss between a nominal 400 Hz signal and 1004 Hz signal, as well as a nominal 2800 Hz signal to a 1004 Hz signal. The attenuation distortion measurement is similar in concept to gain slope, with the exception that it is the differential loss between 1004 Hz and all other required frequencies within the band of interest.

6.23 To perform level and frequency measurements, proceed as follows:

STEP	ACTION
1	Set the QUIET switch in.
	NOTE: This prevents possible signal interference from the transmitter.
2	Set the 20KHZ/4KHZ switch to the type of circuit being tested.
3	Set the LEVEL switch in.
4	Determine if a relative measurement is required to correct to 0 TLP.
5	Set up the TLP relative reference, following the procedures in paragraph 6.19, if required.
	NOTE: The TLP relative reference is cleared from memory if the Model 4410A loses power or is turned off. The message "USE AbS" is displayed when the ABS/REL switch is set to the REL position and the reference has not been set.
6	Set the ABS/REL switch to ABS if a relative measurement is not required. (Testing at 0 TLP.)
	NOTE: The ABS setting vides a measurement reading uncorrected to 0 TLP, even when a TLP relative reference has been programmed.

STEP	ACTION
7	Set the BRDG/TERM switch to the type of measurement mode desired.
	NOTE: The TERM setting provides a balanced, dc blocked termination on the receive circuit for proper loading. The BRDG setting is used when a termination is provided by some other device; therefore, it is not necessary to provide another termination.
8	Set the line interface using the procedures outlined in paragraph 6.12.
	NOTE: If the BRDG/TERM switch was set to TERM in Step 7, it may be necessary to hold up certain supervisory relays in the telephone office with a dc hold current in order to maintain transmission over the facility. Set the RCV HOLD switch in to provide this holding current, if required.
9	Set the DSPL RCV/SEND switch to RCV.
10	Read the measurement values on the display.
11	Push in and hold the 60HZ switch to detect the effect on the measurement.
	NOTE: The 60 Hz filter removes excessive 60 Hz interference caused by power lines. Inserting this filter determines the effect of this interference on the measurement just taken.

G. Absolute Noise and Noise-to-Ground Measurements

6.24 The Model 4410A NOISE operational mode allows measurements to determine the interfering effects of background noise and tones. Message circuit or idle channel noise is typically measured to a quiet termination using one of the three weighting C-Message (C-MSG) filter evaluates the effects of noise corresponding to its annoyance to the "typical" subscriber of standard telephone service, and the effects of noise on voice-grade data transmission. The 3 kHz Flat (3KHZ) filter is used on voice frequency circuits to investigate the presence of low frequency noise caused by such things as power induction and 20 Hz ringing. Comparing a C-Message noise measurement to a 3 kHz Flat measurement for a circuit will identify the low frequency noise interference. Both of these filters are only used on voiceband circuits up to 4 kHz.
The 15 kHz Flat (15KHZ) filter is used to measure noise on program circuits up to 15 kHz. This filter provides an unweighted noise measurement on program circuits.

6.25 The Model 4410A is capable of making noise-with-tone measurements by inserting a 1010 Hz Notch (NOTCH) filter into the noise weighting network.

Noise-with-tone measurements are typically made in the presence of a 1004 Hz holding tone transmitted at -13 dBm0 from the distant end of the circuit under test. Noise-with-tone measurements determine the noise encountered by a continuous data signal or the noise a listener would hear during a speech burst. These measurements are also required where it is necessary to condition compandors or quantizers present in a circuit to their normal operating levels, to duplicate normal operating conditions on the circuit. The holding tone itself is selectively attenuated to >50 dB by the notch filter, thus eliminating the tone before the measurement is made. However, because these measurements are taken on an active circuit, impairments such as quantizing noise, harmonic distortion, and phase or amplitude jitter can cause the noise-with-tone measurement to be higher than an idle channel noise measurement.

6.26 The ability to perform noise-with-tone measurements allows the Model 4410A to make the measurements necessary to calculate the signal-to-noise ratio for a circuit. This is accomplished by taking a C-Notched noise measurement and subtracting the measurement from a level measurement taken from the same tone source. Signal-to-noise ratio is specified for circuits requiring high performance conditioning.

6.27 A noise-to-ground measurement can be obtained when the NTG switch is pushed in with either a C-Message or 3 kHz Flat filter active. Noise-to-ground measurements evaluate the longitudinal noise present on a circuit in reference to ground. A noise-to-ground test is set up like a message circuit or idle channel noise measurement. It is important to note that the Model 4410A must be properly grounded for this function to work correctly.

6.28 To perform absolute noise measurements, proceed as follows:

STEP	ACTION
1	Set the QUIET switch in.
	NOTE: This prevents possible signal interference from the transmitter.
2	Set the 20KHZ/4KHZ switch to the type of circuit being tested.
	NOTE: The TLP relative reference is cleared from memory if the Model 4410A loses power or is turned off. The message "USE AbS" is displayed when the ABS/REL switch is set to the REL position and the reference is not set.
3	Set the ABS/REL switch to ABS.
	NOTE: The ABS setting of the ABS/REL switch provides a measurement reading uncorrected to 0 TLP, even when a TLP relative reference has been programmed.

STEP	ACTION
4	Push in the desired noise weighting filter switch: C-MSG, 3KHZ, 15KHZ.
	NOTE: The type of weighting filter chosen depends on the circuit to be evaluated.
	C-MSG is used to measure noise which is annoying to a "typical" subscriber of standard telephone service, as well as voice grade circuits handling data transmission (600 to 3000 Hz).
	3KHZ is used on voice grade circuits where low frequency noise is suspected. Readings taken with this filter are compared with readings taken with a C-Message filter to determine the effects of the low frequency noise.
	15KHZ is used for unweighted noise measurements on program circuits.
5	Set the BRDG/TERM switch to TERM.
6	Set the line interface using the procedures outlined in paragraph 6.12.
	NOTE: It may be necessary to hold up certain supervisory relays in the telephone office with a dc hold current in order to maintain transmission over the facility. Set the RCV HOLD switch in to provide this holding current, if required.
7	Set the NOTCH switch in if performing a noise-with-tone measurement.
	NOTE: This filter selectively attenuates to >50 dB the 1004 Hz holding tone used in noise-with-tone measurements. It must be used in conjunction with one of the other noise filters.
8	Set the DSPL RCV/SEND switch to RCV.
9	Read the measurement value on the display.
10	Push in and hold the NTG switch to obtain the noise-to-ground measurement, if desired.
	NOTE: This is only used when either the C-MSG or 3KHZ switch is in.

H. Relative Noise and Noise-to-Ground Measurements

6.29 To perform a relative noise measurement, proceed as follows:

STEP	ACTION
1	Set the QUIET switch in.
2	Set the 20KHZ/4KHZ switch to the type of circuit being tested.
3	Select one of the weighting filters, CMSG, 3KHZ or 15KHZ.
4	Set the ABS/REL switch to ABS.
5	Momentarily pushing the SET REF/VIEW REF switch will store the current Model 4410A reading as the reference. If relative measurements with respect to a TLP are needed, perform STEPS 6, 7 and 8. If not, go directly to STEP 9.
6	Set the RCV/SEND switch to SEND.
7	Adjust the generator LEVEL knob to match the TLP.
8	Momentarily press the SET REF/VIEW switch.
9	If there is a holding tone to be notched, set the NOTCH switch to the in position.
10	Set the RCV/SEND switch to RCV.
11	Set the ABS/REL switch to REL.
12	Read the relative noise level from the display.

6.30 If it is necessary to view the reference level against which the noise level is being measured, simply push in the SET REF/VIEW REF switch. Release this switch to resume the relative measurement.

6.31 For making relative noise-to-ground measurements proceed with the steps outlined in Section 6.29 and push in the NTG switch to view the relative noise-to-ground reading.

I. Return Loss Measurements

6.32 The Model 4410A RETURN LOSS mode of operation allows measurement of echo return loss (ERL), low singing return loss (SRL LO), high singing return loss (SRL HI), and single frequency return loss (SINE). Return loss is a measure of the mismatch between the actual transmission circuit impedance and the nominal circuit impedance. Such measurements are important for 2-wire systems providing 2-way transmission because they are subject to line echoes. In addition to echoes, when return loss is low, zero, or negative at any frequency, it causes the circuit to oscillate or "sing." Improperly balanced termsets or hybrid coils also cause echoes or singing, so it is necessary to perform return loss measurements on 4-wire circuits as well.

6.33 A return loss measurement on a 2-wire circuit is the ratio of the transmitted power to the reflected power in dB. Return loss on a properly terminated 4-wire circuit is this power ratio in dB adjusted for any difference in the expected transmission level (TLPs) of the sending and receiving sides due to amplifications, pads, or trans-hybrid loss. When performing a 4-wire return loss measurement, it is necessary to put a short on the 2-wire side of the hybrid in order to "zero-out" or adjust for these effects. The Model 4410A can be set to "zero out" these effects so that, when the short is removed, the corrected return loss measurement can be read directly from the display.

6.34 Echo and singing return loss measurements are made by transmitting band-limited noise of known power, and measuring the energy reflected back from a quiet termination to the transmitter in a 2-wire measurement, or to the receiver for a 4-wire measurement. Single frequency return loss differs somewhat from other return loss measurements, because the measurement is made with a single frequency source rather than noise signal. All the measurements are performed within the 4 kHz voiceband with the ERL test signal energy primarily in the center of the voiceband (500-2000 Hz). The SRL measurements place energy near the edges of the channel bandwidth where singing margins are lest, while single frequency measurements are made at selected frequencies within the voiceband.

6.35 Pushing in the Model 4410A 1004HZ/[ERL] switch while in the RETURN LOSS mode turns on the wideband noise test signal. This signal is passed through a bandpass filter centered in the frequency range of 500 to 2000 Hz.

Pushing in the 404HZ/[SRL LO] switch turns on the wideband noise signal with a bandpass filter centered in the range from 200 to 500 Hz. The 2811HZ/[SRL HI] switch provides the wideband noise signal passed through a filter centered in the range of 2000 to 3700 Hz. Pushing in the VAR/[SINE] switch allows the setting of a frequency via the FREQ adjustment knob for single frequency return loss. Regardless of the type of test chosen, the transmitter output level is adjustable to any desired level within the range of -50.0 dBm to 0.0 dBm. The transmit level is displayed during setup as an aid to performing the test. The frequency is also displayed when a single frequency test is being conducted.

6.36 To perform return loss measurements, proceed as follows:

2-Wire Measurement

STEP	ACTION
1	Set the QUIET switch in. **NOTE:** This prevents inadvertent transmission of the signal.
2	Set the 20KHZ/4KHZ switch to 4KHZ.
3	Set the DSPL RCV/SEND switch to SEND.
4	Set the 4W/2W switch to 2W.
5	Set the RETURN LOSS switch in.
6	Set the ABS/REL switch to ABS.
7	Set up the transmitter output signal following the procedures in paragraph 6.17, Steps 1 through 11. **NOTE:** The functions labeled in red are the transmitter outputs when operating in the RETURN LOSS Mode. Select the function corresponding to the type of test to be conducted.
8	Set the BRDG/TERM switch to TERM.
9	Set the line interface using the procedures outlined in paragraph 6.12. **NOTE:** It may be necessary to hold up certain supervisory relays in the telephone office with a dc hold current in order to maintain transmission over the facility. Set the SEND HOLD switch in to provide this holding current, if required.
10	Set the DSPL RCV/SEND switch to RCV. **NOTE:** Failure to set this switch to the RCV position will result in an improper internal hybrid circuit adjustment leading to erroneous measurement results.
11	Apply a short to the circuit under test.
12	Set the QUIET switch out.
13	Push in and hold the SET REF/VIEW REF switch.

STEP	ACTION
	NOTE: The display flashes when the relative reference has been set. In the RETURN LOSS mode, the relative reference is used to "zero out" hybrid imbalance and trans-hybrid loss. In a 2-wire measurement the adjustment is made to the hybrid circuit in the Model 4410A.
14	Remove the short applied in Step 11.
15	Set the ABS/REL switch to REL.
	NOTE: A 2-wire return loss measurement is a relative measurement which is a ratio of the transmitter output and the signal reflected back to the transmitter from a quiet termination.
16	Read the measurement value on the display.
17	Set the ABS/REL switch to ABS.
	NOTE: Failure to reset this switch at the conclusion of return loss testing will lead to incorrect LEVEL or NOISE mode measurements. If required, it may be necessary to reset the relative reference for adjustment to a 0 TLP following the procedures in paragraph 6.19.

STEP	ACTION
	4-Wire Measurements
1	Set the QUIET switch in.
	NOTE: This prevents inadvertent transmission of the signal.
2	Set the 20KHZ/4KHZ switch to 4KHZ.
3	Set the DSPL RCV/SEND switch to SEND.
4	Set the 4W/2W switch to 4W.
5	Set the RETURN LOSS switch in.
6	Set the ABS/REL switch to ABS.
7	Set up the transmitter output signal following the procedures in paragraph 6.17, Steps 1 through 11.
	NOTE: The functions labeled in red are the transmitter outputs when operating in the RETURN LOSS mode. Select the function corresponding to the type of test to be conducted.
8	Set the BRDG/TERM switch to TERM.
9	Set the line interface using the procedures outlined in paragraph 6.12.

STEP	ACTION
	NOTE: It may be necessary to hold up certain supervisory relays in the telephone office with a dc hold current in order to maintain transmission over the facility. Set the RCV HOLD switch in to provide this holding current, if required.
10	Set the DSPL RCV/SEND switch to RCV.
	NOTE: Failure to set this switch to the RCV position will result in an improper adjustment for the termset hybrid leading to erroneous measurement results.
11	Apply a short on the 2-wire side of the termset hybrid of the circuit under test.
12	Set the QUIET switch out.
13	Push in and hold the SET REF/VIEW REF switch.
	NOTE: The display flashes when the relative reference has been set. In the 4-wire RETURN LOSS mode, the relative reference is used to "zero out" the termset hybrid transmit and receive imbalance due to amplification pads and trans-hybrid loss.
14	Remove the short applied in Step 11.
15	Set the ABS/REL switch to REL.
	NOTE: A 4-wire return loss measurement is a relative measurement which is a ratio of the transmitter output, and the signal reflected back to the receiver from a quiet termination adjusted for amplification, pads, or trans-hybrid loss in the hybrid.
16	Push in the ECHO SUPP switch, if required.
	NOTE: This disables any echo suppressors or cancellers present in the circuit under test. Since a return loss measurement is a loop-around type measurement, these devices must be disabled for a proper measurement.
17	Read the measurement value on the display.
18	Set the ABS/REL switch to ABS.
	NOTE: Failure to reset this switch at the conclusion of return loss testing will lead to incorrect LEVEL or NOISE mode measurements. If required, it may be necessary to reset the relative reference for adjustment to a 0 TLP following the procedures in paragraph 6.19.

7. PACKING/SHIPPING, AND RETURN TO FACTORY

7.01 This section contains directions for the packaging and shipment of the Model 4410A, and special instructions for identification tagging when returning the unit to HLI for servicing or repair. Because the Model 4410A contains no user serviceable parts, the factory should be consulted when a problem is encountered with the unit. A telephone or written inquiry identifying the problem will assist HLI in providing a recommendation for corrective action. Should a return to the factory be necessary, specific instructions would be provided.

7.02 It is recommended that the original packing materials and shipping container for the Model 4410A be retained and stored for use when it may become necessary to ship the unit between your locations or to the factory.

A. Return for Repair or Service

7.03 If the unit is being returned to HLI for repair or servicing, enclose the following information:

- Type of repair service required.
- Model and serial number.
- Return address and contact name.
- Return authorization number, if any.

Keep a copy of this information for your records. Refer to the information on any correspondence with HLI.

B. Packing and Shipping

7.04 If original packing materials and shipping container are unavailable, repack the unit as follows:

STEP	ACTION
1	Wrap the complete unit in heavy kraft paper or plastic. Tape any loose edges.
2	Surround the wrapped unit with 2 to 4 inches (5 to 10 cm) thick shock absorbing material. **NOTE:** Newspapers may be used.
3	Place the wrapped package in a strong shipping container.
4	Fill the excess spaces with shipping filling material or newspapers.
5	Seal the container securely.
6	Mark the container: FRAGILE-DELICATE ELECTRONIC INSTRUMENT

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